1884

The production of spelter as practiced at the Glendale Zinc Works

Arthur Neustaedter

Department:

18

84

A

THESIS FOR THE DEGREE

of

MINING ENGINEER

A. Nieuwenhuizen.

18

84

Subject.

The subject of this thesis is, "The production of Spelter as practiced at the Glendale Zinc Works."

Description of the Zinc Works.

The "Glendale Zinc Works" are situated in the southern part of the city of St. Louis, on the line of the St. Louis Iron Mountain and Southern R. R. and among the iron manufacturing districts. They are the only zinc works now in operation, and produce a large quantity of spelter.

Outline of process.

I will now proceed to give an outline of the process and the ores of them seperately giving more into detail. The ores treated at these works are the "Blende" or "Jack" and the Calamine. The "Blende" is crushed, and then roasted, while the "Calamine" is first calcined and subsequently crushed. The "Blende" and "Calamine" are mixed with bituminous coal, placed in a retort, to which an

intense heat is applied, the zinc distils and condenses in the condenser from which it is drawn.

Details of process.

I will now proceed to give the details of the process, as carried on at these works, commencing with the mining of the ore, and ending in the production of spelter. In convenience I will treat of them under the following heads —

Ores.

Mining of ores.

Prep. of "Blende" before roasting.

" " "Calamine" after calcining.

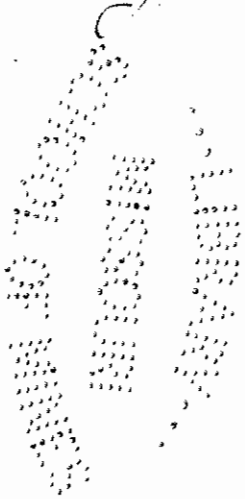
Roasting.

Calcining.

Retorts.

Condensers.

Smelting.



Ores

"Blende"

This is a combination of Zn with S

having the formula ZnS, containing when pure 67.08% of Zn and 32.92% of S. A specimen from these works gave

ZnS =

Zn =

This ore of zinc occurs either in veins traversing the older rocks, or in floors and bunches in more recent formations. The first mode of occurrence is perhaps the most frequent; but the more recent deposits are generally the most productive. This mineral occurs either massive, or in dodecahedra and octahedra forms. Its color, resin-yellow, to black (from impurities). Gravity about 4 1/2. The "Blende" is mined at Joplin, in the south-western part of the state of Missouri.

"Calamine."

The "calamine" is associated with "Blende", and is also obtained from Joplin. This ore is a hydrous silicate of Zn. having the formula $ZnO^2SiO_2 + H_2O$,

containing when pure 65.663% of ZnO, 25.967% of Li_2O, and 8.38% of H_2O. A specimen from this mine gave

ZnO = 63.212

Li_2O = 22.289

H_2O = 7.220

CO_2 = 4.329

Al_2O_3 = 1.403

MgO = .094

CaO = .487 and Fe_2O_3 = .917

It occurs in mammillated, massive granular and crystalline forms, its color is yellow.

Mining of these ores at Joplin.

The ore as it comes from the mines of Joplin, is laid out on a platform and the associated "galena" is separated from it, with the aid of a hammer, it is then jigged, by a jigging apparatus of the following description - The jig consists of a box immersed in water, and by a proper arrangement is made to

move up and down rapidly, causing the lighter material, as earthy matter, rocks and etc, to rise, which are washed away, leaving the ore in the box, The washing is conducted in a series of jigs. The ore is now ready for shipment, the cost, per ton at the present time is $21.50 for the "Blende" and for "Calamine" $17.

Prep. of "Blende" before roasting.

The jiged "Blende" is crushed between steel-rollers, it should pass through a 36 in. mesh, this being the proper fineness. The steel-rollers can crush from 30, to 40 thousand pound per day. They employ 2 men, one tends to the crushing, while the other is employed to run the engine, it is thence taken to the roasting furnaces. They receive resp. 1.50 and 2.75.

Prep. of Calamine after calcining.

In the case of the Calamine, the

ore is first calcined, and subsequently crushed in exactly the same way as in the case of the Blende. They crush about the same amount of ore.

Roasting.

Before Zn. can be extracted from the "Blende", it must be roasted, that is it must be converted to the oxide, this is done by roasting the Zn. S., driving of the S in the form of SO_2, leaving it as Zn O. The roasting at these works is performed in double-reverberatory furnaces, having an upper, and lower department, 16 working doors, 8 above and 8 below, a high chimney, about 50 ft. in height, a hopper and a fire-place, for dimensions of furnace and demensions see Figs I and II.

Working of a charge.

I shall take a single furnace, and go into the detail of roasting. They generally put a quantity of the crushed Zn S on top of the roaster,

allowing it to remain there some time, thence 700 lbs are transfered to the upper department, through a hopper in front of door number I, it remains there some time, being frequently stirred by means of iron paddles, it is now removed to door no II, while a fresh supply is put in number I, number II is moved along to number III, and number III to number IV, at number IV there is an opening, allowing the partially roasted "Blende" to be transfered to the lower department, then moved along to door number VIII, where it is tested to see if any sulpher remains, if the workmen see that there is no more than 2% remaining, he draws it from the furnace, and is removed to the smelting furnaces. Each single furnace roasts from 6,000 to 6,200 per. day of 12 hours, 12,000 per. 24, employing experienced workmen, receiving .06 per 100 lbs, They have 3 double-roasters

roasting in an average 70,000 lbs. per. day of 24 hours.

Calcining.

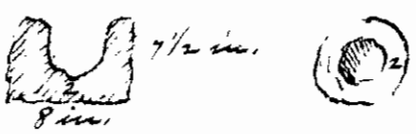
Calcining is resorted to in the case of Calamine. The calcining is done in an ordinary lime-kiln, the object being to drive of the water contained in it, 80,000 lbs are thrown in, the size being, as large as a doubled fist, and calcined for from 4 to 5 days, it is then crushed, and put into sheds.

Retorts.

As retorts are used in smelting the ore, I will first give the manner in which they are made. The Company has a department for making retorts and condensers aside of the crushing department. They employ 8 hands, very skilled in their trade, in fact all the men employed, are men of experience, having had much practice.

Making Retorts.

The retorts are made of crushed fire clay and old broken retorts. The fire clay and old broken retorts are mixed together, moistened with water and tempered, when this is done the one who attends to this, rolls it in long round rolls, of about 3½ ft. in length and 1 inch in thickness. The bottom of the retort is first made, by taking out a lump of the material, rolling it into the form of a small cylinder and giving it a depression, it takes the form as shown in the figure below.



when this is completed, the rolls are rolled around, the bottom up to ½ its intended height, being 2 inches, the outside is craped smooth, with a piece of wood, a piece of cloth is now wraped around the ½ retort. is put

in its mould, which is a cast iron shell, having a cylindrical form, opened and closed by hinches, fig III. represents the mould. The inside is next craped & smooth with a craper, a rammer is then plunged into the hollow of the cylinder, which is an instrument shown in fig. IV. a borer is now placed into the hollow of the cylinder, and turned around, this making the sides compact and giving it proper diameter, when this operation is completed it heaters, with the heater, it being a stick shod with iron. fig V. represents it, the last operation is smoothing the inside, or as they them it, polishing. The other ½ is built upon this, in exactly the same way, of course there is no bottom made.

The retort is 4 9" long, 10" in external diameter and 8" in internal. They are then taken to the drying house.

which is heated from the waste steam of the engine employed in the steel-smelters, kept there from 4 to 6 weeks, from thence they are removed to the kilns, burnt there from 12 to 15 hours, and are then ready for use. They employ 4 men, receiving .17 ¢ p. a piece, they make from 17 to 20 per. day of 12 hours.

Condensers.

The condensers are made of the same material, as the retorts

Making Condensers.

In making the condensers the clay is annealed, a large hunch is placed in the bottom of a mould, it being made of cast-iron, having the shape of a hollow truncated cone, a rammer is now rammed into the middle of it, this gives it its proper form, the mould with the condenser in them carred to

its proper place, he taps it, which loosens it from its mould, they are next dried for a week or two, burnt, and are ready for use. They employ two men, receiving .01¢ a piece, they make from 250 to 300 per day of 12 hours. The condensers are forty.

Smelting.

The final treatment is the smelting, from it we obtain the metallic zinc. This is effected by the action of carbon on the zinc oxide, by the aid of heat; the reaction is shown below.

$$ZnO + CO = Zn + CO_2$$

Furnaces.

The furnaces employed at these works, are double-furnaces, 16 by 16 by 14 ft. The back of the opening, meaning by the back the wall between the front walls of the double furnaces, which hold the closed end of the retorts, is slightly inclined in the direction ab

as shown in fig. VI. The fire place F, is placed beneath the surface of the ground, the flame and heated air enter the interior of the furnace through 7 openings c, in each single furnace is placed 108 retorts, 11 in a row, and 10 rows height, On the open face of the furnace, are arranged 10 plates of cast-iron, protected on the inner side by fire-clay; these are destined for the support of the condensers. The height of the steps at the back of the furnace and that of the iron plates in front of the openings, is so arranged as to give the retorts a slight inclination.

Working of a charge.

Assume that a charge has been taken out, and the retorts and condensers have been cleaned. The one which is in front of the furnace consist of 2/3 blende 1/3 calamine and pulverized bituminous coal,

the workmen throw in the charge with semi-cylindrical shovels, a shovel holds about 10 lbs of the mixture. 50 lbs. air thrown in, the condensers are now united to the retorts with fire clay, the fire urged; at first there is a dense black smoke, which last about 15 minutes. Then a flue flame appears at the openings of the condensers. At the expiration of a further period the brilliancy of the combustion is considerably increased, and the flame at the same time assumes a greenish-yellow tint, and gives off copious white fumes, at this period, they place air the ends of the condensers, wrought iron adapters to catch as much ZnO as possible, At the expiration of 2 hours, the workmen remove the adapters, tap them, and save the ZnO for future use. When

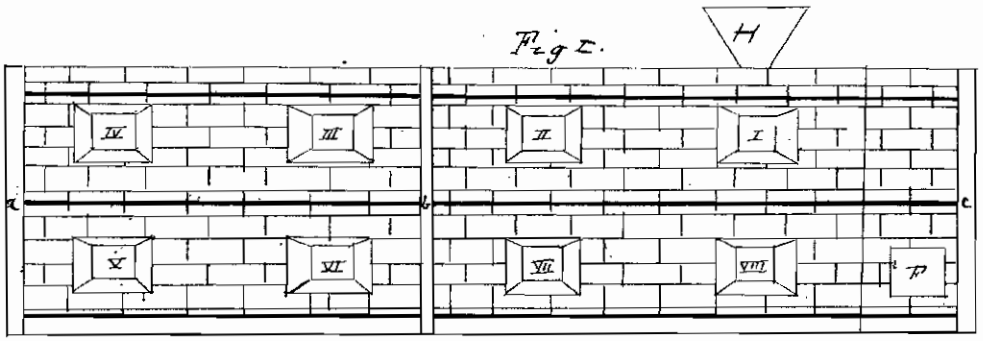
This has been done, an assistant holds a large iron ladle under the beak of each condenser, at the same time that the foreman draws out into it with an iron scraper the distilled zinc, which is put into moulds, a mould holding 50 lb. The manipulations are repeated at intervals of two hours, in about 12 hours time the distillation has commonly terminated. They obtain 20 lbs of Zn from 50 lbs of ore, employing 3 men at each single furnace. They work day and night, they have 4 double furnaces, although they generally only run three. At the expiration of 2 months they deem it necessary to repair a furnace, so that while three are running the other is being repaired, they men receive from 2.50 to 3.50, depending upon the seniority of position. The retorts last from 1 to 2 months, the top ones last longer.

The following are analysis of the spelter produced at these works.

Zn	=	99.263054
Pb	=	.542891
Cd	=	.164365
Fe	=	.009353
Sb.	=	.007097
Cu	=	.006152
SiO_2	=	.002320
As.	=	.001768
Bi	=	Trace.
S	=	
C	=	
		100.000000

The present cost of spelter is $4.37½ per hundred pounds.

Fig I.



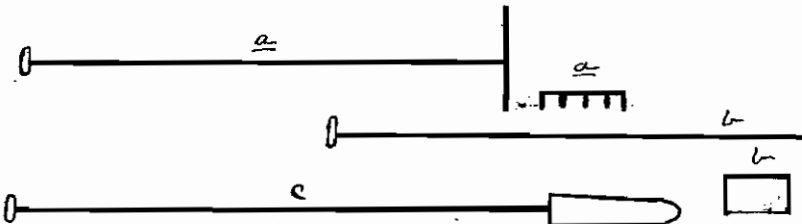
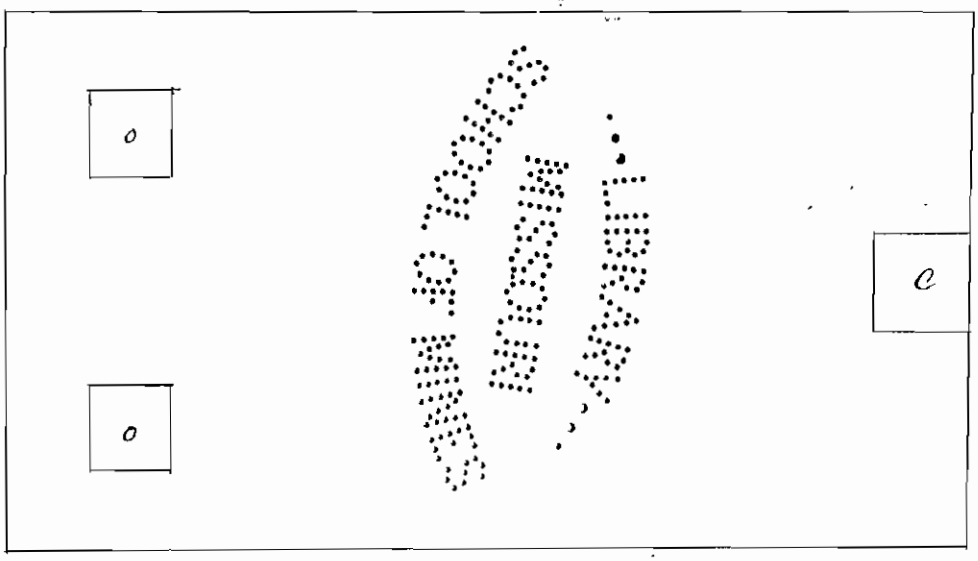


Fig I. represents a longitudinal section of roaster.
I, II, III, etc. are working doors.
a, b, a are bands of iron.
F is the fire-place.
A single furnace is 30 by 9 by 8.
H is the hopper.
Fig a a, b and c are tools used.
Fig a is a rake.
Fig c is a rabbler.
Fig b is used to draw the roasted ore from furnace.

Fig II rep. horizontal section through top floor.
O, O are door through which the ore is transfered to lower department.
C is the flue.

Fig. II.



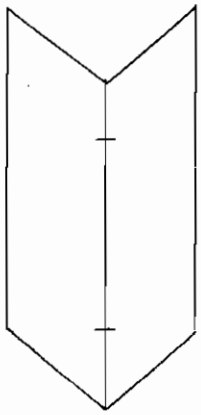
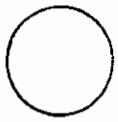
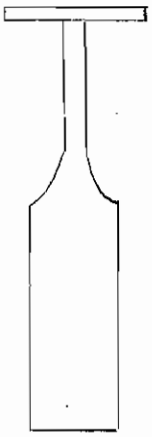
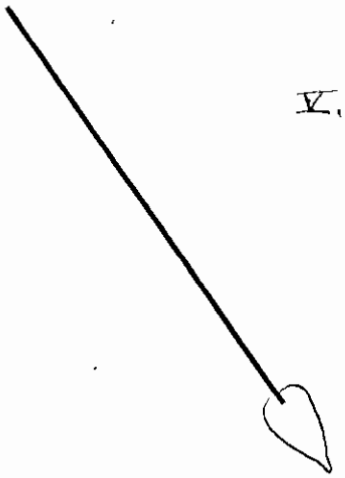


Fig III.





VI.
a borrer.



V.

Fig IV.

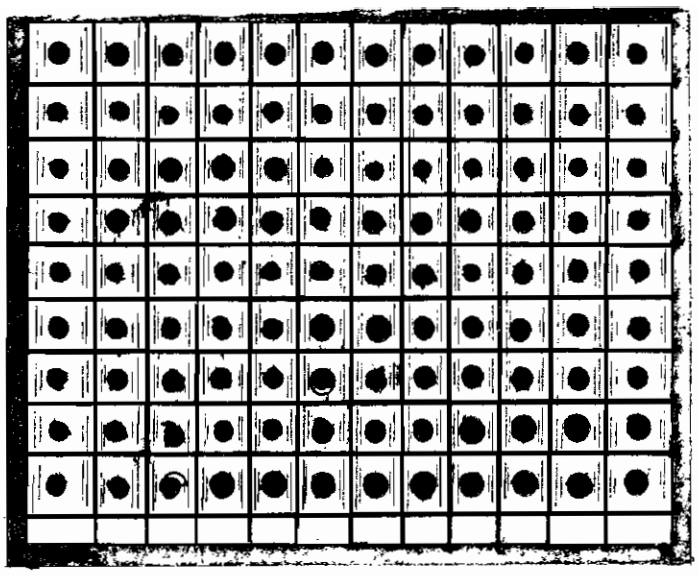


Fig VI. Represents horizontal and vertical sections.
c. c c are the condensers.
b. b. b. " " returns.

VI.